2.1 Biodiversity and Evolution

Classification Hierarchy – Page 3

		Completed
1.	• Read about the 5 Kingdom versus the 3 domain classification system page 2 and complete the questions • Read about new classification systems page 3 and complete the questions	
2.	• Read about the hierarchical classification system a. What is a taxon? b. Place the seven major taxa in order from the largest to the smallest. Create a mnemonic to help you remember the order. c. The different taxa form a hierarchy. What does this mean?	
2.	• Use the PowerPoint to complete the hand-out summarising the main features of each of the five Kingdoms.	
3.	• Use the PowerPoint to complete the hand-out summarising the main features of each class of chordates	
4.	• Use the PowerPoint to make notes about annelids	
5.	• Use the PowerPoint to make notes about arthropods • Watch brainpop animations on insects and arachnids • Go to shapeoflife.org and watch video about annelids	

The New Tree of Life

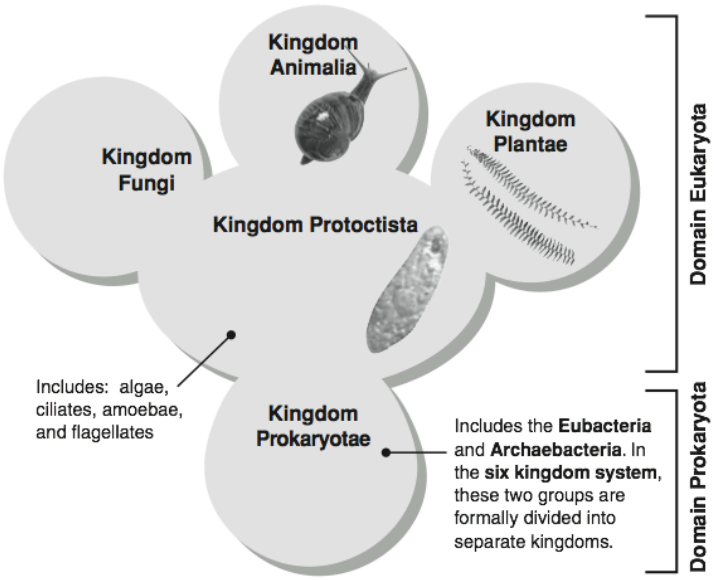
With the advent of more efficient genetic (DNA) sequencing technology, the genomes of many bacteria began to be sequenced. In 1996, the results of a scientific collaboration examining DNA evidence confirmed the proposal that life comprises three major evolutionary lineages (domains) and not two as was the convention. The recognised lineages were the **Eubacteria**, the **Eukarya** and the **Archaea** (formerly the Archaebacteria). The new classification reflects the fact that there are very large differences between the archaea and the eubacteria. All three domains probably had a distant common ancestor.

A Five (or Six) Kingdom World (right)

The diagram (right) represents the **five kingdom system** of classification commonly represented in many biology texts. It recognises two basic cell types: prokaryote and eukaryote. The domain Prokaryota includes all bacteria and cyanobacteria. Domain Eukaryota includes protoctists, fungi, plants, and animals. More recently, based on 16S ribosomal RNA sequence comparisons, Carl Woese divided the prokaryotes into two kingdoms, the Eubacteria and Archaebacteria. Such **six-kingdom systems** are also commonly recognised in texts.

A New View of the World (below)

In 1996, scientists deciphered the full DNA sequence of an unusual bacterium called *Methanococcus jannaschii*. An **extremophile**, this methane-producing archaebacterium lives at 85°C; a temperature lethal for most bacteria as well as eukaryotes. The DNA sequence confirmed that life consists of three major evolutionary lineages, not the two that have been routinely described. Only 44% of this archaebacterium's genes resemble those in bacteria or eukaryotes, or both.



Domain Eubacteria

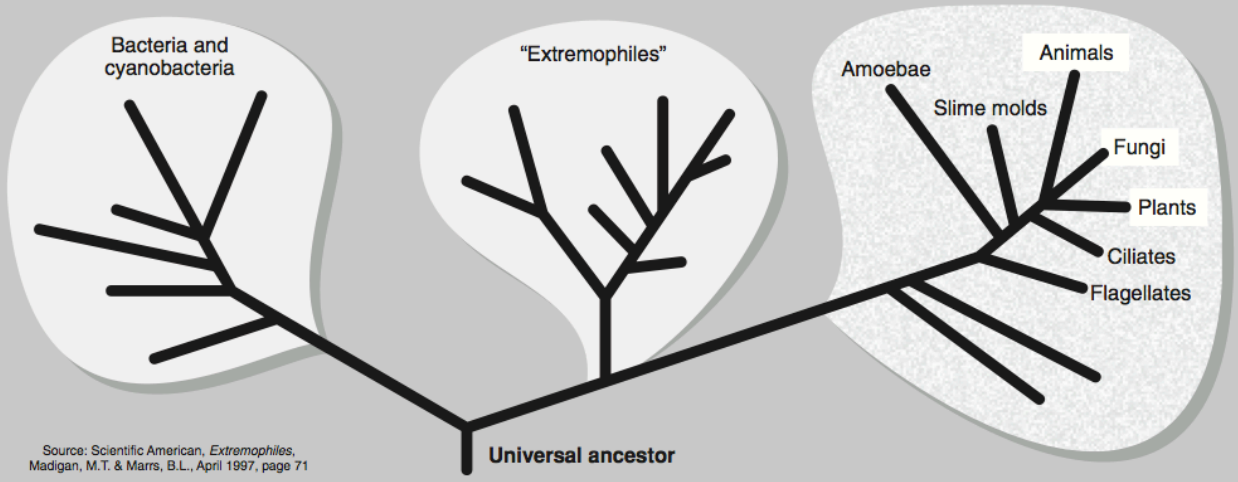
Lack a distinct nucleus and cell organelles. Generally prefer less extreme environments than Archaea. Includes well-known pathogens, many harmless and beneficial species, and the cyanobacteria (photosynthetic bacteria containing the pigments chlorophyll *a* and phycocyanin).

Domain Archaea

Closely resemble eubacteria in many ways but cell wall composition and aspects of metabolism are very different. Live in extreme environments similar to those on primeval Earth. They may utilise sulfur, methane, or halogens (chlorine, fluorine), and many tolerate extremes of temperature, salinity, or pH.

Domain Eukarya

Complex cell structure with organelles and nucleus. This group contains four of the kingdoms classified under the more traditional system. Note that Kingdom Protoctista is separated into distinct groups: e.g. amoebae, ciliates, flagellates.



Source: Scientific American, *Extremophiles*, Madigan, M.T. & Marrs, B.L., April 1997, page 71

1. Explain why some scientists have recommended that the conventional classification of life be revised so that the Archaea, Eubacteria and Eukarya are three separate domains:

_____

_____

2. Describe one feature of the three domain system that is very different from the five kingdom classification:

_____

_____

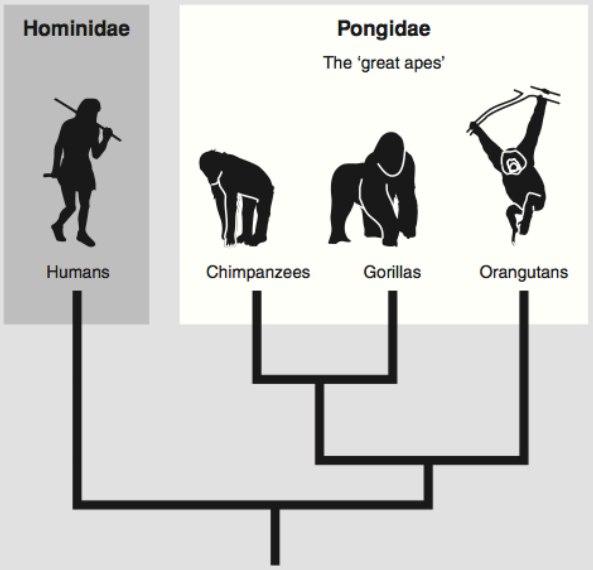
3. Describe one way in which the three domain system and the six kingdom classification are alike: _____

_____

New Classification Schemes

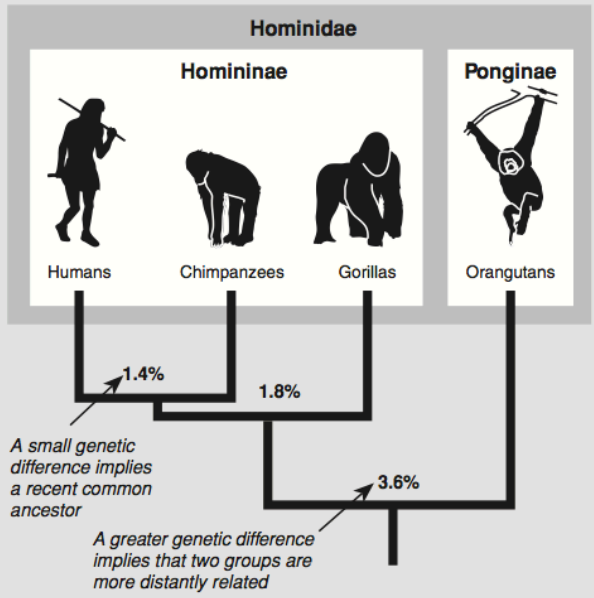
Taxonomy is the study of classification. Ever since Darwin, the aim of classification has been to organise species, and to reflect their evolutionary history (**phylogeny**). Each successive group in the taxonomic hierarchy should represent finer and finer branching from a common ancestor. In order to reconstruct evolutionary history, phylogenetic trees must be based on features that are due to shared ancestry (homologies). Traditional taxonomy has relied mainly on **morphological characters** to do this. Modern technology has assisted taxonomy by providing **biochemical evidence** (from proteins and DNA) for the relatedness of species. The most familiar approach to classifying organisms is to use **classical evolutionary taxonomy**. It considers branching sequences and overall likeness. A more recent approach has been to use **cladistics**: a technique which emphasises phylogeny or relatedness, usually based on biochemical evidence (and largely ignoring morphology or appearance). Each branch on the tree marks the point where a new species has arisen by evolution. Traditional and cladistic schemes do not necessarily conflict, but there have been reclassifications of some taxa (notably the primates, but also the reptiles, dinosaurs, and birds). Traditional taxonomists criticise cladistic schemes because they do not recognise the amount of visible change in morphology that occurs in species after their divergence from a common ancestor. Popular classifications will probably continue to reflect similarities and differences in appearance, rather than a strict evolutionary history. In this respect, they are a compromise between phylogeny and the need for a convenient filing system for species diversity.

A Classical Taxonomic View



On the basis of overall anatomical similarity (e.g. bones and limb length, teeth, musculature), apes are grouped into a family (Pongidae) that is separate from humans and their immediate ancestors (Hominidae). The family Pongidae (the great apes) is not monophyletic (of one phylogeny), because it stems from an ancestor that also gave rise to a species in another family (i.e. humans). This traditional classification scheme is now at odds with schemes derived after considering genetic evidence.

A Cladistic View



Based on the evidence of genetic differences (% values above), chimpanzees and gorillas are more closely related to humans than to orangutans, and chimpanzees are more closely related to humans than they are to gorillas. Under this scheme there is no true family of great apes. The family Hominidae includes two subfamilies: Ponginae and Homininae (humans, chimpanzees, and gorillas). This classification is monophyletic: the Hominidae includes all the species that arise from a common ancestor.

1. Briefly explain the benefits of classification schemes based on:

   (a) Morphological characters: _____

   _____

   _____

   (b) Relatedness in time (from biochemical evidence): _____

   _____

   _____

2. Describe the contribution of biochemical evidence to taxonomy: _____

   _____

3. Based on the diagram above, state the family to which the chimpanzees belong under:

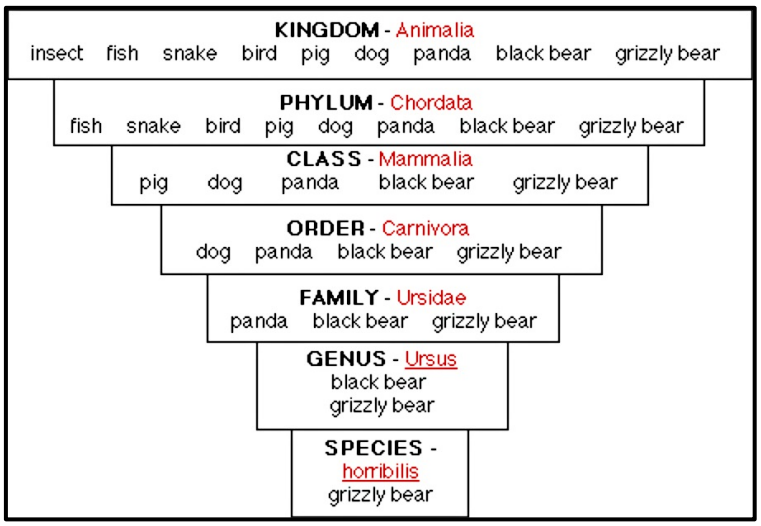
   (a) A traditional scheme: _____ (b) A cladistic scheme: _____

Hierarchical Classification

The basic unit of biological classification is the species. Biochemical, morphological, ecological, behavioural features are all used to help classify species.

Closely related species are grouped together into **genera** (singular: **genus**). Genera are grouped into **families**, families into **orders**, orders into **classes**, classes into **phyla** (singular phylum) and phyla into **kingdoms**. This is the **hierarchical system** of classification; each successive group contains more and more different kinds of organisms.

Each grouping of organisms within the hierarchy is called a **taxon** (plural: **taxa**) and each taxon has a rank and a name for example class Mammalia or genus *Homo*.



THE FIVE KINGDOMS CLASSIFICATION

The species is the basic unit of classification but classification of organisms does not end with the designation of a specific name. It is also necessary to devise a system of widening groups into which organisms can be placed in order to draw further comparisons. Species are classified into groups that show many similarities of features. These groups of species are, in turn, classified into fewer larger groups that share fundamental similarities.

Many different classification systems have been devised throughout history. For a long time, all living organisms were grouped into either the plant Kingdom or the animal Kingdom. However, as more organisms were discovered and studied in more details, they could not all fir into those two categories. Nowadays, the most commonly used system is the Five Kingdom System, a version of which was originally designed by American biologist R. H. Whittaker in 1959.

Features of the Five Kingdoms

The classification of organisms into taxonomic groups is based on how biologists believe they are related in an evolutionary sense. Organisms in a taxonomic group share features which set them apart from other groups. By identifying these features, it is possible to develop an understanding of the evolutionary history of the group. The focus of this activity is to summarise the **distinguishing features** of each of the five kingdoms in the five kingdom classification system.

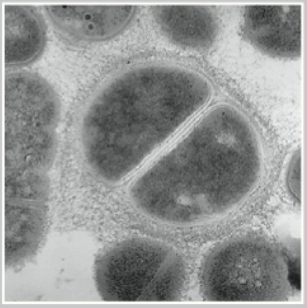
1. Distinguishing features of Kingdom **Prokaryotae**:

2. Distinguishing features of Kingdom **Protoctista**:

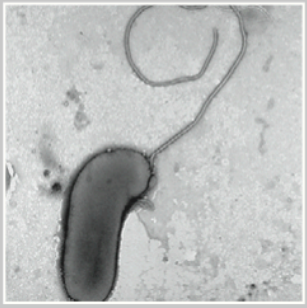
3. Distinguishing features of Kingdom **Fungi**:

4. Distinguishing features of Kingdom **Plantae**:

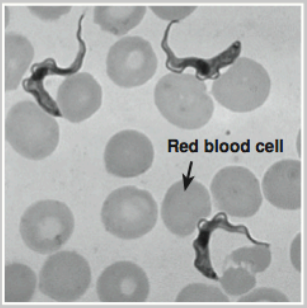
5. Distinguishing features of Kingdom **Animalia**:


EII

***Staphylococcus* dividing**

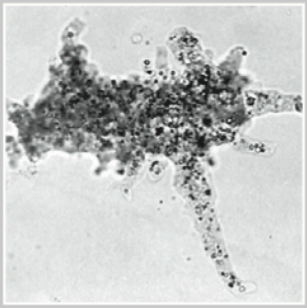

EII

Helicobacter pylori



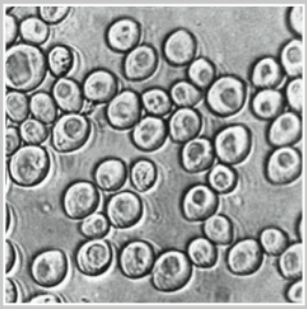
CDC

***Trypanosoma* parasite**


RCN

Amoeba

Mushrooms



Yeast cells in solution

Maple seeds

Pea plants


RA

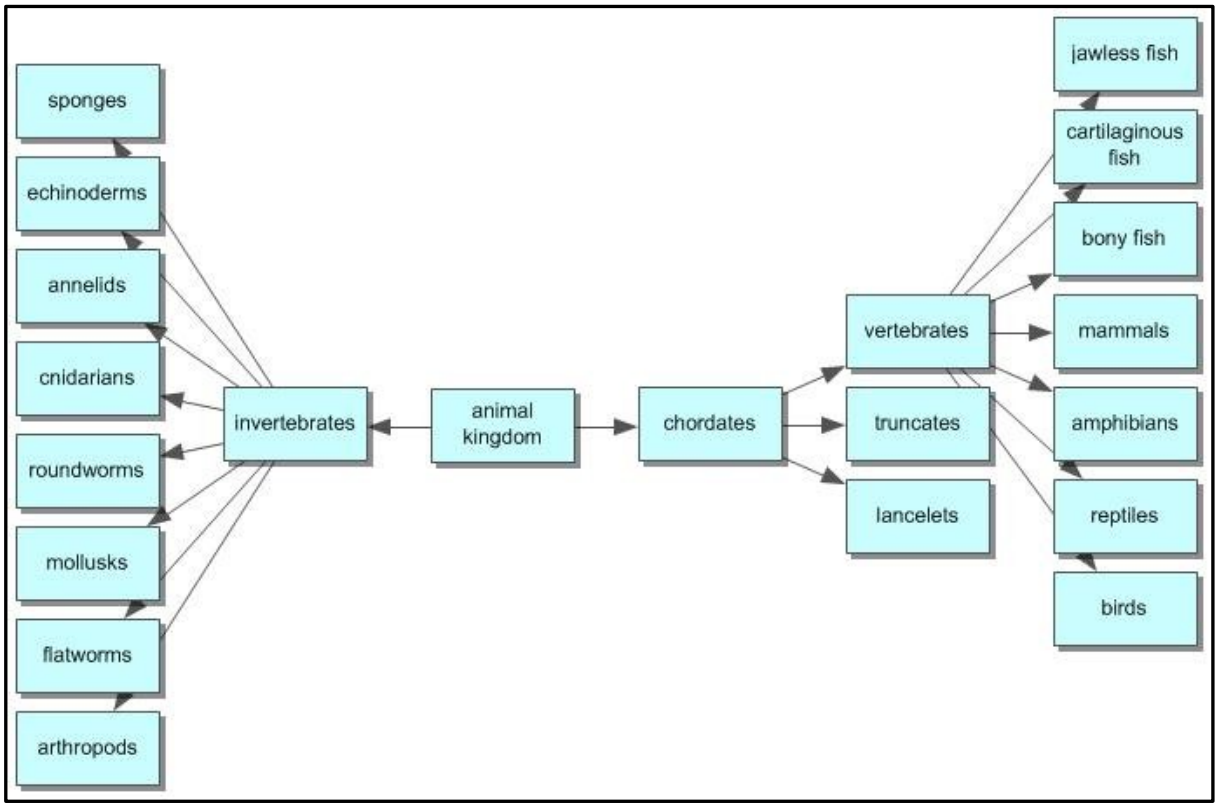
Cicada moulting

Gibbon

Animal Kingdom

Animals have no cell walls, are multicellular and carry out heterotrophic nutrition. The animal kingdom has over 800.000 species and so far 33 different phyla (plural for phylum) have been described. The phyla are divided on the basis of body symmetry, type of body cavity and external and internal structures.

Animals are classified as shown:

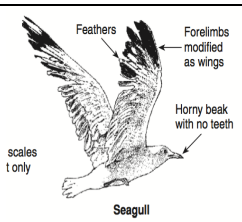
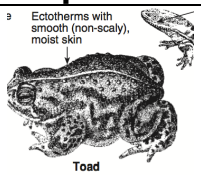
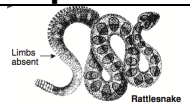
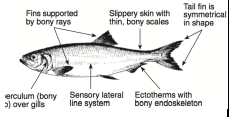


As can be seen the animal kingdom is divided into two main groups.

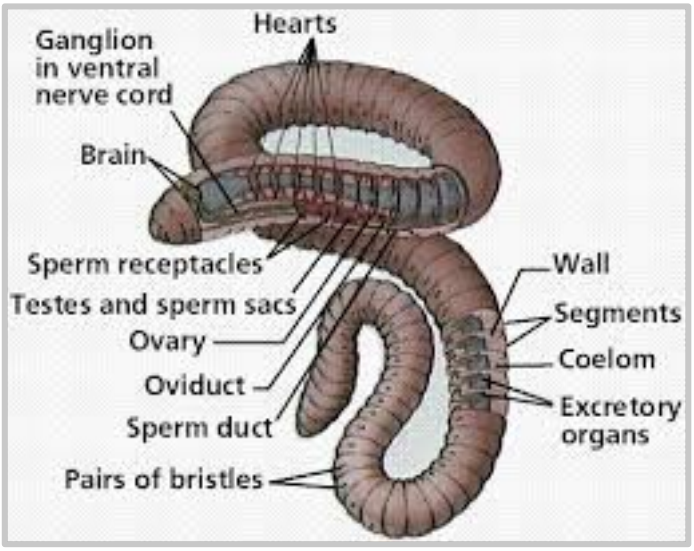
- Non-chordates, also called invertebrates, examples include arthropods and annelids
- Chordates – all but the simplest have a vertebral column and include fish, birds, mammals, reptiles and amphibians.

There are 60,000 named species of chordates.

They possess a vertebral column or backbone and a well-developed CNS enclosed in a cranium and an internal skeleton. Chordates are divided into birds, mammals, amphibians, reptiles and fish.

Class	**Birds**	**Mammals**	**Amphibians**	**Reptiles**	**Fish**
Picture	 Seagull	 Wildebeest	 Toad	 Rattlesnake	
Body Covering					
Gas Exchange					
Reproduction					
Body Temperature					
Limbs					
Terrestrial / Aquatic					

Annelids
(go to shapeoflife.org and watch video on annelids)



8000 named species.

Annelida means 'little ring' in Latin.

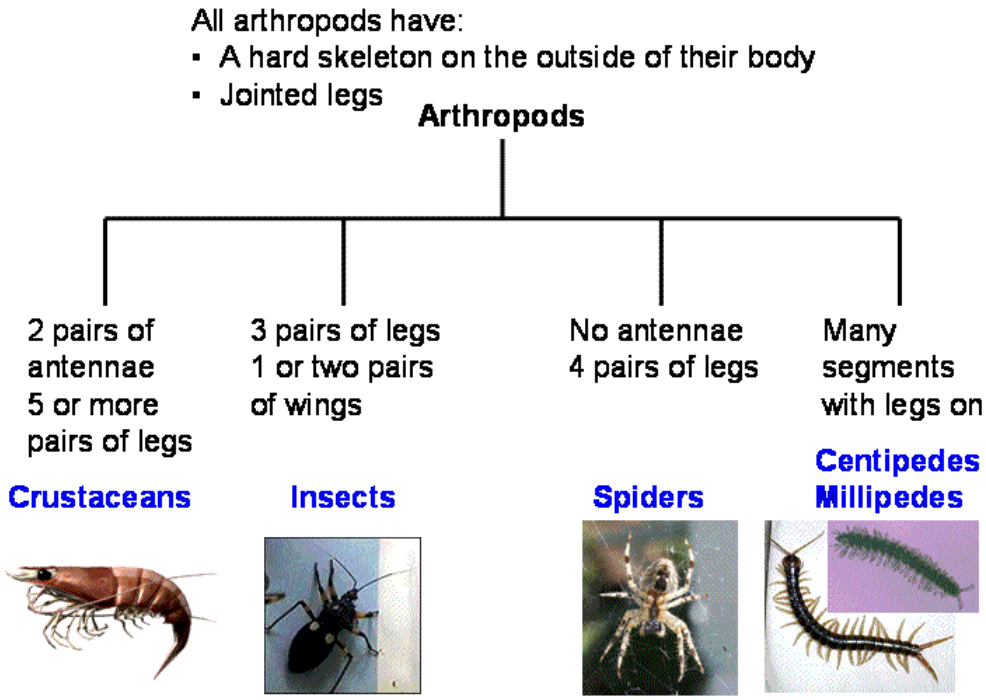
Annelids are far from being lowly worms: They are impressively powerful and capable animals that have adapted to live in most habitats on earth.

Annelids include: earthworms, polychaetes (marine worms), and leeches.

Features of the Phylum

- Elongate and bilateral with segmentation
  The evolution of segmentation was an important step for the annelids because it provided an opportunity for separate regions of the body to specialize for different tasks.
- A coelom (body cavity)
  A body cavity provides a fluid system against which the muscle system can work effectively. This is why annelids are such effective burrowers.
- Complete circulatory system with capillaries, arteries and veins
- Body wall made of circular and lengthwise muscles
- Continuous gut running from mouth to anus with its own musculature isolated from locomotion musculature
- Bristle-like structures, called setae
  Setae are thin chitinous structures projecting from body (except in leeches) which help the worm move.

Arthropods



All arthropods share the following 3 characteristics:

The advantages and disadvantages of an exoskeleton are:

Advantages:_____

Disadvantages:_____